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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN No. 43.

B. T. GALLOWAY, Chief of Bureau.

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JAPANESE BAMBOOS

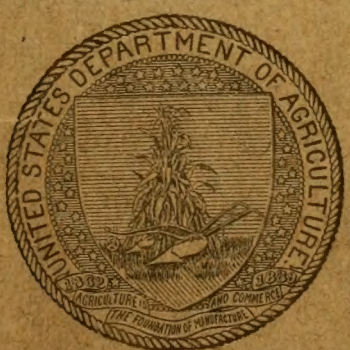
AND THEIR INTRODUCTION INTO AMERICA.

BY

DAVID G. FAIRCHILD, Agricultural Explorer.

SEED AND PLANT INTRODUCTION AND DISTRIBUTION.

Issued July 3, 1903.



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A COMMERCIAL GROVE OF BLACK BAMBOO (PHYLLOSTACHYS NIGRA), NEAR KYOTO, JAPAN.

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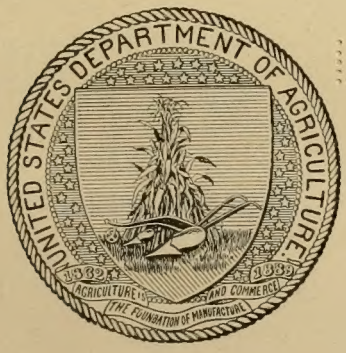

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BUREAU OF PLANT INDUSTRY.

BEVERLY T. GALLOWAY, *Chief of Bureau.*

SEED AND PLANT INTRODUCTION AND DISTRIBUTION.

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MAR 31 1903
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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., May 16, 1903.

Sir: I have the honor to transmit herewith a paper entitled "Japanese Bamboos and Their Introduction into America," and respectfully recommend that it be published as Bulletin No. 43 of the series of this Bureau.

This paper was prepared by Mr. David G. Fairchild, Agricultural Explorer, who has been detailed by you to accompany Mr. Barbour Lathrop on his expeditions in search of valuable seeds and plants, and it has been submitted by the Botanist in Charge of Seed and Plant Introduction and Distribution with a view to publication.

The illustrations which accompany this paper, consisting of eight half-tone plates, are considered essential to a full understanding of the text.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

PREFACE.

The bamboo has long been known as one of the best of ornamentals wherever the climate is sufficiently mild to permit of its cultivation, but besides its value as an ornamental the bamboo has in its native home a multitude of uses which make it one of the most important plants in the economy of Japanese life.

Both Mr. Barbour Lathrop and Mr. Fairchild are convinced that the bamboo may be adapted to many uses in America, and the present bulletin is intended to call attention to the possibilities in this direction and to describe some of the most important species.

A. J. Pieters,
Botanist in Charge.

Office of Botanist in Charge of
Seed and Plant Introduction and Distribution.
Washington, D. C., May 8, 1903.

CONTENTS.

	Page.
Introduction	9
General considerations	10
General characters of the Japanese bamboos	14
Propagation of Japanese bamboos	16
Suitable location and soil conditions for bamboos	19
Japanese management of bamboo groves	21
Profits of bamboo culture in Japan	23
Culture of the edible bamboo	24
Different species of bamboos	25
Phyllostachys mitis	27
Phyllostachys quilioi	27
Phyllostachys henonis	28
"Madaradake" or "Ummon-chiku"	28
Phyllostachys nigra	29
Phyllostachys castillonis	29
Phyllostachys aurea	30
Phyllostachys bambusoides	30
Phyllostachys marliacea	31
Arundinaria japonica	31
Arundinaria simoni	32
Arundinaria hindsii	32
Arundinaria hindsii, var. graminea	33
Bambusa veitchii	33
Bambusa palmata	33
Bambusa quadrangularis	33
Bambusa vulgaris	34
"Shakutan"	34
Description of plates	36

ILLUSTRATIONS.

Page.

PLATE I. Commercial grove of black bamboo (*Phyllostachys nigra*), near Kyoto, Japan ..... Frontispiece.

II. A well-kept forest of timber bamboo (*Phyllostachys quilioi*) on good soil 36

III. Fig. 1.—A well-kept forest of timber bamboo (*Phyllostachys quilioi*) on poor soil. Fig. 2.—A badly kept forest of timber bamboo (*Phyllostachys quilioi*) on good soil 36

IV. Bamboo groves in Japan. Fig. 1.—A hillside forest of edible bamboo, 20 years old. Fig. 2.—A grove of edible bamboo more than 100 years old. Fig. 3.—Twelve-day-old shoot of *Phyllostachys quilioi* in forest of same timber species 36

V. Bamboo groves in Japan. Fig. 1.—Clump of *Arundinaria simoni*, showing persistent sheaths. Fig. 2.—Grove of *Phyllostachys quilioi*, age unknown. Fig. 3.—Plat of a species of bamboo called "Hanchiku" 36

VI. Fig. 1.—Black bamboo plant, showing the effect of the death of the rhizome. Fig. 2.—Properly dug young plant of black bamboo. Fig. 3.—Rhizome of bamboo, with young shoots and roots springing from nodes 36

VII. Fig. 1.—A few dwarf bamboos. Fig. 2.—Embankment of *Bambusa veitchii* in Tokyo. Fig. 3.—Sawdust on surface of shoot, indicating presence of culm-boring larva. Fig. 4.—Longitudinal section of shoot, showing culm-boring larva 36

VIII. Bamboos in California. Figs. 1 and 3.—*Phyllostachys quilioi* (?) on the grounds of a nursery company at Niles. Fig. 2.—Clump of *Phyllostachys quilioi*, the second year after transplanting at Niles . 36

JAPANESE BAMBOOS AND THEIR INTRODUCTION INTO AMERICA.

INTRODUCTION.

This bulletin represents a small part of the work accomplished by Mr. Barbour Lathrop's third expedition in search of valuable seeds and plants, and comprises material gathered during a four months' stay in Japan.

Its object is to call the attention of American cultivators to a group of the most beautiful and useful of all plants which has hitherto been neglected by them, either because they believe it adapted only to a tropical climate or to be of only ornamental value, and to point out how far both of these views are fallacious.

Anyone who has attempted to collect data in an Oriental country will appreciate the difficulties which are encountered in working through an interpreter, and will understand that some of the statements in this bulletin must depend upon the accuracy of the translations. Mr. K. Yendo, of the botanic gardens in Tokyo, was, however, particularly well fitted to interpret on botanical matters, and it is hoped few errors have been made.

The writer wishes to express his indebtedness and gratitude for assistance to Mr. T. Makino, of the Tokyo Botanic Gardens, who is the Japanese authority on bamboos; Mr. Isuke Tsuboi, of Kusafuka, near Ogaki, who is one of the best amateur cultivators of these plants; and especially to Mr. H. Suzuki, of Yokohama, for most valuable advice and assistance regarding transplanting and shipping.

The valuable work of Sir Ernest Satow on "The Cultivation of Bamboos in Japan," in Volume XXVII of the Transactions of the Asiatic Society of Japan (1899), and above all, "The Bamboo Garden," by Mr. Freeman Mitford (1896), which is the most attractive and useful book ever written on this group of plants, have been drawn upon largely, especially in the preparation of the descriptions of the various species.

GENERAL CONSIDERATIONS.

The bamboo groves of Japan are not only one of the most striking features of its landscapes but one of its most profitable plant cultures.

The largest well-kept groves in the world, except perhaps those of Burma, are growing in the central provinces, and some of these are several square miles in area. In the Tropics generally the bamboo is cultivated in small clumps, but in Japan it is grown with almost the same care that is given to the field crops.

No other nation has found so many artistic uses for the plant as the Japanese, and in no other country, except it be China, is such a variety of forms employed by the common people.

The plant is a necessity to the Japanese peasant; it forms one of the favorite themes of the Japanese artist, and out of it are manufactured some of the most delicate works of Japanese art. The bamboo is in fact one of the greatest cultivated plants of this plant-loving race.

It is a popular misconception that bamboos grow only in the Tropics. Japan is a land of bamboos, and yet where these plants grow it is not so warm in winter as it is in California. In regions where the snows are so heavy that they often break down the young stems and where the thermometer drops to 15° (F.) below the freezing point, the largest of the Japanese species grows and forms large groves.

For many years the gardens of France and England have been beautified by clumps of these Japanese bamboos, and even in America occasional plants can be found growing in the open air, which prove the possibility of acclimatizing these representatives of this most useful family of plants. A temperature of 6° F. has not proved fatal to a large number of the hardy kinds in England.

Although nearly every description of those regions where bamboos grow gives some account of their uses, there is still in the minds of many Americans a doubt as to the value of these plants for growth in the United States.

Bamboos are not like new grains or fodders which will yield prompt returns in money, but they are essentially wood-producing plants, whose timber is unlike that of any temperate-zone forest trees, and is suitable for the manufacture of a multitude of articles for which our own woods are not well adapted. They are the most convenient plants in the world for cultivation about a farmhouse, and in those regions where they can grow would, if introduced, prove themselves in time one of the greatest additions imaginable to the plants of the common people.

The Japanese and Chinese, who are the most practical agriculturists in the world, have for centuries depended upon the bamboo as one of their most useful cultures, and the natives of tropical India and the Malay Archipelago would be much more at a loss without it than the

American farmer without the white pine, for they are not only dependent upon it for their building material, but make their ropes, mats, kitchen utensils, and innumerable other articles out of it, and at the same time consider it among the most nutritious of their vegetables. To enumerate the uses of such a family of plants as this would be like giving a list of the articles made from American pine, and it would not serve the purpose of this bulletin so well as to simply point out the fact that the wood of this bamboo is suited to the manufacture of a different class of articles and fills a different want from that of any of our American woods. Every country schoolboy is aware of the superiority of a bamboo fishing pole over any other. Its flexibility, lightness, and strength distinguish it sharply from any American poles, and make it better suited for a fishing rod than one made from any wood grown in this country. It is because the American schoolboys are so firmly convinced that the bamboo fishing poles are the best that the importers are warranted in shipping into the United States from Japan every year several millions of them.[a]

The thin, flexible ribs of the imported Japanese fan are made from the wood of the same plant, and no one can fail to recognize the peculiar fitness of the material for this particular use.

These are two uses of bamboo wood which illustrate its character, and must be familiar to nearly everyone. When one realizes, however, that they are selected from over a hundred, which would be just as familiar to the Chinese or Japanese, it seems highly probable that this wood must be applicable to many other needs among Americans, which a closer acquaintance with it would reveal. Santos Dumont has employed bamboo extensively in the framework of his dirigible balloons, and Edison once used it in his incandescent lamps.

Americans see in America only the imported poles or manufactured articles as a rule, and from these it is very difficult to imagine the multitude of uses to which the green, uncured stems are put. It is for just such things as can be made quickly from the green shoots that the plant is peculiarly fitted, and this suitability for making all sorts of handy contrivances is one of the principal reasons why it should be made a common plant among the farmers of those parts of our country where it will grow.

The bamboos belong to the family of the grasses, and if this fact is kept in mind many peculiarities of their habits and characters will be easily understood. They should be distinguished, however, from the reeds, of which we have a number in America, especially such as are called "bamboo reed" or "Arundo" (*Arundo donax*), a rank-growing grass, with stems bearing long broad leaves to their very bases.

[a] The writer was informed by a large grower near Kyoto that 10,000,000 are exported from Japan every year, and that the largest share of them goes to America.

These reeds, although useful, have very soft stems, which are entirely different in texture from those of the true bamboo. The canebrakes of the South are made up of a species of bamboo, but unfortunately the wood of this species is of very little value. The tall, plume-like stem of the bamboo, which sometimes reaches a height of 100 feet, has many of the characteristics of a giant grass (Pl. I). It is composed of joints, is hollow (Pl. VIII, fig. 1), and grows to its full height from a creeping underground stem in a few days, quite as does a shoot of quack grass. The rapidity with which a new culm grows is one of the most remarkable facts about it, and often bewilders the layman, who is accustomed to judge the age of a tree by its size (Pl. VII). Over a foot a day is not an unusual rate during the most rapid growth—a rate of 3 feet per day has been recorded—and a shoot more than 20 feet high may be less than fifty days above the ground. Its development may be compared in a rough way to that of a shoot of asparagus, and anyone who has seen how easily a young stem of bamboo can be snapped off by merely shaking it will appreciate this comparison.

In common with the stems of grasses, those of the bamboo have a hard, siliceous exterior, which makes them more impervious to moisture and more durable than ordinary wood of the same weight. The presence of partitions at short intervals, which cut up the hollow stem into natural receptacles, is another valuable characteristic. These partitions can, however, be easily removed, and the hollow stem used as a pipe, or the pipe can be split open from end to end to form two semicylindrical troughs. The ease with which the green stems can be split into slender pieces, which range in size from half that of the stem itself to the fineness of a horsehair, is one of the most remarkable qualities of the wood, and makes it adapted to innumerable kinds of basket, sieve, screen, and mat making. The fact that no long process of curing is necessary before stems which have been cut fresh from the forest can be used is one of the qualities that makes the plant of such great convenience in the peasant homes of the Orient. Many of the articles of bamboo manufacture could be replaced by metal ones, but it is the convenience of having always at hand a stock of material which can be easily made into a host of improvised things that makes the plant so valuable. This latter is a point which should appeal especially to Americans, who are called the handiest people in the world.

The employment of the young sprouts as a vegetable is alone worthy of the serious attention of our cultivators, for the fondness which many American residents show for bamboo shoots indicates the possibility of creating a demand for them in America.

But in addition to the uses of the bamboos as timber and food plants their value from an æsthetic standpoint is incontestable. They are among the most graceful forms of vegetable life that exist, and add an indescribable charm to any landscape (Pl. I). No one who has

ever seen them in China or Japan can fail to have been impressed with their beauty or convinced of the great charm which they lend to the otherwise often monotonous character of the scenery. They are waving plumes of delicate green foliage, which, whether seen against the sky line or backed by a darker mass of forest, always give a peculiar softness to the scene.

Nearly every farmhouse has growing near it a clump of some one of the useful species, and the graceful mass of culms transforms what would be an uninteresting plaster and tile house into a pretty, picturesque home.

It is, however, the introduction of the hardy representatives of this remarkable family of plants into the United States that should attract the attention of Americans, and the object of this bulletin is to show how the various kinds of bamboo are cultivated in Japan, and to suggest how these methods of cultivation can be applied to American conditions.

As might be expected, in a group of plants containing hundreds of species, there is a great range of hardiness among them. Some of the Japanese forms are able to thrive in the coldest regions of Hokkaido, the North Island, while others are too tender to be grown successfully even in the comparatively mild climate of the central provinces.

There is also a great range in the size of the different species. Some are so small that they creep over the ground, forming a reed-like, rank-growing greensward (Pl. VII, fig. 2), while others grow to a height of 40 feet or more and produce stems which are 6 and 7 inches in diameter (Pl. IV). Certain forms are suited only for potting purposes and are chosen by the Japanese gardeners as objects upon which to practice their dwarfing art (Pl. VII, fig. 1), while others are grown in forests which are many acres in extent.

While the introduction into America of some of the smaller forms is a desirable matter, the main interest attaches to securing and establishing the hardy forest species.

As previously remarked, there are many plants of Japanese bamboos already growing in America. Clumps of the very hardy kinds may be seen occasionally in private gardens or public parks in the South, even as far north as Washington; but owing either to the difficulty of getting the plants or a failure to understand their management these have never become popular farm plants. Potted specimens of the small species are to be met with in many florists' collections, and some are used as lawn plants, but the employment of even these is very limited.

In California, where the Japanese and Chinese species thrive very well, there are many large specimens, and even one small forest, while a number of Californians are enthusiastic bamboo fanciers. Dr. H. Tevis, of San Francisco, has probably the largest collection on the

Pacific coast, and his brother has a grove at Bakersfield in which stems over 40 feet high are said to be growing. The Golden Gate Park has several clumps which are very promising, and Mr. McLaren, the superintendent, was most enthusiastic over an offer by Mr. Lathrop to present several thousand to the park, with which to start a grove or two of more than a half acre in extent. In the grounds of a nursery company at Niles, Cal., there are several rows (Pl. VIII) of the timber bamboo, individuals of which are certainly 25 feet in height; and a beautiful little grove, probably of *Phyllostachys quilioi*, in the town of Berkeley, was destroyed a few years ago to make way for a street. In Florida the well-known nursery firms have already imported many different species.

Mr. Lathrop is assisting the Department of Agriculture in an attempt to introduce on a large scale the best of the Japanese timber sorts and arouse the interest of a large class of cultivators in those regions where the plants are likely to succeed, and it is to be hoped that the time is not far off when many thousands of young plants will be set out through these sections of the United States.

GENERAL CHARACTERS OF THE JAPANESE BAMBOOS.

Bamboos are not trees, although their stems or culms are sometimes as large as tree trunks, and it is essential that their character as grasses be kept in mind.

They have the power of producing seeds, which resemble (in Japanese species, at least) kernels of rice or barley, but they flower as a rule only at intervals of many years, and very few of the flowers ever form seed. The formation of mature seed is so uncommon in Japan that Mr. Makino, of the Tokyo Botanic Gardens, who is writing a monograph on the family, says he has never seen the seed of certain of the common species.

In the almost total absence of the method of reproduction by seed the bamboos have developed their rhizomes, or underground stems, and it is upon these that the spread and multiplication of the individuals depends. Unlike an ordinary tree, therefore, a clump of bamboos has underground stems in addition to its root system. A mass of these creeping rhizomes, which grow out in various directions from the base of the clump, give rise every year to the new shoots which increase the diameter of the clump. A single rhizome, according to Dr. Shiga, chief of the bureau of forest management in Tokyo, continues growing for four seasons and then ceases, but from the bases of the shoots it produces new rhizomes grow out which have a similar period of growth. If these underground stems or rhizomes are injured or checked in any way from spreading freely through the soil, the clump of aërial shoots will remain small; but if given rich soil and abundance

of moisture a few plants will spread gradually until they cover a considerable area.

The new shoots of bamboo are produced by different species at different seasons of the year. The majority of Japanese species send up their new stems in the spring, beginning in April and May, and it is these sorts that stand the best chance of succeeding in America, because our cold winters will kill back any young growth produced late in the summer.

This growing period is the most critical one in the life of the plant, as the shoots during development are easily injured by winds, frosts, or droughts, and it is upon the growth of these young stems that the beauty of the clump during the summer depends.

If one examine a rhizome of bamboo (Pl. VI, fig. 3) it will be seen to have at short intervals partitions or nodes, above each of which is situated a small pointed bud, and from each bud arises a number of fibrous roots. It is by the elongation and thickening of these buds that the new shoots are formed, and if it is injured, though the rhizome may remain alive for many years, it will not produce any new buds or shoots from these nodes.

When a bud at the node of one of the underground stems has swollen until it is much larger in diameter than the rhizome which supports it and has sent down a number of good, strong roots, it begins to elongate and push its way up through the soil. Tough, overlapping sheaths protect the tender tip from injury, as well as the undeveloped branches on the sides of the elongating shoot. These sheaths are borne on alternate sides of the stem by each internode or joint (Pl. IV, fig. 1), and are, according to Sir Ernest Satow, characteristic of each species.[a] They are tough and board-like, many of them, often covered outside with fine bristles and characteristically marked; and the tip of each is provided with a leaf-like appendage called *pseudophyll*, which varies in shape with each species. These protecting organs remain closely attached to the stem until it has nearly finished its growth, when they stand out from the stem, allow the young branches hidden beneath to develop, and finally drop off. In some species the sheaths remain attached longer than in others, and in certain species they never drop off, but gradually dry up and break to pieces.

Until the young stem has attained its full height it is quite branchless, like a shoot of asparagus. On reaching maturity, however, the sheaths fall back and the young branches elongate and unfold their leaves. Most large forest bamboos have no branches near the ground, the first four or six nodes failing to produce them. When grown in

[a] The Cultivation of Bamboos in Japan, Trans. Asiat. Soc. Japan, Vol. XXVII, Part III, 1899. Price, 5 yen.

dense masses even the first twenty or more are often devoid of branches. The smaller the shoot the more likely it is to branch from the lower nodes.

The leaves of bamboo vary greatly in size, but have one general lanceolate form, some being nearly a foot long by 6 inches wide, and suitable for wrapping material; but the majority of forest forms at least have leaves from 2 to 6 inches long. Mr. Mitford points out in his most interesting book, "The Bamboo Garden," that the leaves of all hardy species in England have not only the parallel longitudinal nerves which are common to all bamboos, but delicate cross nerves which give a leaf the appearance, when held up to the light, of being covered with a network of veins. All species tested by him which did not have these "tesselated" leaves, as he calls those leaves with cross as well as longitudinal veins, proved tender in England.

Little use is made of the foliage of most species of bamboo, a few only being used for fodder where better food in not obtainable. One species in Hokkaido is said to be browsed over by the few cattle which are there. When first produced the young foliage is often of a dark-green color, but as it becomes older it changes to a lighter shade of green, and on very old culms it often has a yellowish tinge. These differences in the color of the foliage are what give such a variable appearance to a bamboo forest.

Although produced in a few weeks, a stem requires three or four years to harden and become fit for use, and if left standing in the forest too long, or until it becomes yellow, it loses much of its elasticity. Culms that are twenty years old have lost much of their beauty, the foliage becoming scant and the stems yellow and scarred.

The roots of the bamboo resemble those of Indian corn. They are brittle and easily broken and are never of any great size, but are formed in large masses from the nodes of the underground stems.

PROPAGATION OF JAPANESE BAMBOOS.

If Japanese bamboos produced seed, the cheapest and safest way to propagate them would be by importing large quantities of the latter and growing them in seed beds; but as none of the useful species bears fruit, except at very long intervals, it is necessary to propagate the plants by other means. Two methods have been practiced, one of which, however, is only used to a limited extent.

The safest way is the simple one of digging up young plants, separating them from the mother clumps, and transplanting them to the desired situation. This method seems very simple, but there are several essential points regarding it which must be attended to if the transplanting is to prove a success. If the transplanting is only from a forest to a location near by, it may be done at any time during

the growing season. In Japan this period extends from April until July, inclusive. If, however, the plants are desired for planting in a foreign country, America, for example, they should be dug early in April, set out in nursery rows, and allowed to grow until the middle of July. Those which in July show a new growth from the rhizome should then be transplanted again into the same kind of soil, and in October they will be in condition for digging and shipment. Mr. Tsuboi, of Kusafuka, cuts back the culms on his young plants to one or two nodes when he first digs them in April, at which time they form a rosette of leaves near the ground (Pl. VI, fig. 1). When treated in this way they produce small plants which would be very economical for shipping, as they require little box space.

Much depends upon the selection of the young plants whether or not a vigorous clump results from its planting in a few years. The mother plant should be inspected to see if it is in good health. If the branches are affected by what is known as "witches' broom," which makes gnarled, irregular tangles of the small branches, young plants should not be taken from them. A species of smut (Ustilago) sometimes affects the young branches and produces an appearance similar to that of the witches' broom, but this is less abundant than the former disease. The larva of a species of beetle, whose habits are not yet fully known so far as could be ascertained, sometimes causes considerable damage by boring into the young shoots and penetrating through segment after segment of the young growth, stunting the culm and completely ruining it for timber purposes (Pl. VII, figs. 3 and 4). A young plant in bloom is considered worthless for transplanting, as it seldom gives rise to new shoots.

The proper way is to select a young plant with branches near the ground and cut down with a spade or other cutting tool on all sides of the base at a distance of not less than 8 inches, severing the rhizomes which connect the plant with the mother clump. Dig out a good-sized ball of earth with the roots inclosed in it, shake off the superfluous earth, cut back the stem to two branch-bearing nodes, and transfer to a nursery row (Pl. VI, fig. 2). If no rhizome is dug up with the plant, or if the rhizome is dead, the plant may live on for several years, a rosette of leaves forming at the top of the stem, without the formation of any new shoots (Pl. VI, fig. 2). Mr. Tsuboi is of the opinion that plants with dead rhizomes will live for seven or eight years and appear perfectly healthy. The plant is kept alive by the fibrous roots, but has no power to form a new rhizome. In the purchasing of plants from nursery companies the principal point to ascertain is whether the rhizome is alive and in vigorous condition. The part above ground may be to all appearances in good health, while the rhizome is dead, making the plant worthless.

If these properly dug plants which have been set in nursery rows

in April are inspected in July some of them will have begun the formation of new shoots from their active rhizomes. Plants of which the rhizomes show no signs of activity, it should be emphasized, are probably weak and should not be chosen for the second transplanting, especially if designed for a long ocean voyage. In October the twice-transplanted bamboos, hardened by this transplanting process, are dug and their roots, together with a ball of earth, are wrapped with coarse straw twine, surrounded with a layer of moist sphagnum, and packed carefully in well-aired boxes. All holes in such boxes should be carefully closed with wire netting to keep out rats during the voyage. Very little foliage should be left on the plants when they are shipped in this way (see Pl. VI, fig. 2). October is the best month for shipping from Japan, because the plants have by that time gone into a dormant condition and travel safer, and the extreme cold weather will not have begun before they reach their destination in America.

Even with these precautions, the plants on arrival after a sea voyage require special attention. According to Mitford, who has had much experience with their importation, they should not be planted out in their permanent places before they have recovered from the effects of the journey. The balls of earth should be first thoroughly soaked in water and the plants then potted and placed in a cool house for the winter. The leaves, or bare culms, if the leaves are lost, should be copiously syringed twice a day, but the roots should not be kept too moist. Early in May the plants should be hardened off as one hardens off geraniums for bedding out, and at the end of May or beginning of June they will be ready to plant in their permanent places.

This should be in soil which has been especially prepared the previous autumn by double digging to a depth of 18 inches. In setting out, great care should be taken not to trample down the soil too roughly about the roots, as there is great danger of injuring the brittle buds on the rhizomes or the tender fibrous roots. It is best, Mr. Mitford says, to consolidate the plants by watering freely. After planting, the ground should be thickly covered with a mulch of dried leaves (Pl. II), under which is a layer of cow manure; and this mulch should be kept on during the summer months to allow the plants to form a good strong system of underground stems and fibrous roots.

The above method, which embodies the experience of such students of the bamboo as Mr. Mitford, Mr. Tsuboi, and Mr. H. Suzuki, is probably the safest one and in the end most economical.

It has been found unnecessary by such cultivators as Mr. J. McLaren and Mr. John Rock, of California, to pot the plants on arrival in such a warm climate as California. They are merely heeled in, given plenty of water, and set out the following spring.

The other method of propagation is to dig up, in the winter, lengths

of 1-year-old rhizome 3 feet or so long, rub the cut ends with wet ashes, allow these wet ashes to dry, and pack carefully in a tight box in fine, almost dry soil (Pl. VI, fig. 3). Upon arrival these rhizomes are set out in properly prepared ground. The shipment should be timed to arrive at its destination in the early spring, so that the cuttings can be set out at once. This method is recommended by Mr. Mitford for the commercial nursery propagation of the bamboo, but he does not advise its employment if the plants are to be shipped long distances, and the author has failed to find that it has been successfully tried. Mr. John Rock, of Niles, Cal., thinks bamboos could be propagated quickly in this way.

Even with the best of care in transplanting by the first described method the Japanese bamboo growers count on losing at least 10 per cent of their young plants, and if the conditions are not altogether favorable, as high as 20 per cent of failures may be expected.

SUITABLE LOCATION AND SOIL CONDITIONS FOR BAMBOOS.

In Japan some of the best groves are surrounded by paddy fields, and the soil is a rich, stiff loam, lightened with a mixture of sand. Those visited by the writer are on the open plain and stretch up and down a small brook for 5 miles or more. Whatever winds blow over this small plain must strike the forests, but it is safe to say that such winds are not strong ones. A favorite site for a bamboo grove is the base of some range of hills or a broad valley where some mountain stream has brought down and deposited a mass of alluvium. These situations have the double advantage of suitable soil and shelter from strong winds. This latter point is said by every grower to be an important one, for the young shoot, as soon as it is tall enough to come in contact with the branches of the older ones, is thrashed about by the winds and its growing tip is injured. This injury stops its growth at once and the resulting culm is imperfect. Wind-breaks of conifers are sometimes planted to protect a grove which is in an exposed position. In America, where the prevailing winds are probably as a rule stronger than they are in Japan, special attention will have to be given to this matter of wind-breaks.

The quality of the soil on which a bamboo stem is grown influences materially the texture of its wood. So fully is this realized by the Japanese that there is one particular mountain side which has the reputation of producing the hardest, flintiest bamboo in the country. The culms grown at Togeppo are cut up and made into the cylindrical ash boxes, or "haifuki," upon the edge of which the smokers strike their metal-trimmed pipes in order to knock out the ashes. After years of use the edge of the Togeppo ash box remains smooth, while that made from a stem grown in the lowlands is splintered to pieces.

Potash and phosphoric acid are very important elements in the formation of a strong, tough wood, and although their use in fertilizers does not make so much difference in the rapid growth of the culm as that of nitrogen they are quite as important.

A well-drained soil is just as necessary for bamboos as for many trees, for although these plants require much moisture they are not swamp plants, like canes or reeds. Land which is occasionally overflowed can be planted to advantage with bamboos, according to Mr. Tsuboi, if they are set on low mounds or ridges; but stagnant pools of water will kill the rhizomes if allowed to stand over them for many weeks. Embankments of canals, the borders of ponds, and river banks are suitable situations, especially in dry regions. Large clumps are growing along the canals in Egypt, and Algiers has many varieties growing in her trial gardens which are watered only by irrigation. There are in California, Oregon, Texas, and throughout the Gulf and Southern States thousands of suitable locations. The banks of small streams, the deltas of rivers, low, irrigated islands, like those in the San Joaquin and Sacramento rivers, would produce big forests of these valuable plants, while the banks of irrigation canals, wherever such occur in mild climates, could be made beautiful by them. Any soil which has a large admixture of gravel in it does not prove satisfactory, as the gravel prevents the rapid spreading of the underground stems. Such compact soils as the gumbo soils of the Southwest will probably grow the plants well, but they will presumably not spread as rapidly on such stiff ground as they would upon a lighter loam. If it is the object to produce a large number of big culms, the best soil is one with a fair admixture of vegetable humus. The rhizomes spread rapidly in such humus and produce a fine crop of new shoots. As the roots of the forest species penetrate 3 feet into the soil, the writer is assured that a clay subsoil at this depth is a desirable soil condition. In the cultivation of the edible bamboos (*Phyllostachys mitis*) a lighter, more sandy soil seems to be preferred to that deemed suitable for the timber kinds, *P. quilioi* and *P. henonis*. Most bamboos will not withstand much drought without losing their leaves, but they are not so dependent upon a moist atmosphere as most people imagine. If they are supplied with plenty of water at the roots their leaves will keep green in a fairly dry climate. They must not be considered, however, as drought-resistant plants, but as suitable for irrigated land or regions in which there is at least a moderately regular rainfall. At Niles, Cal., Mr. Rock has bamboos 20 feet high which are watered only twice a year with about 2 inches of water each time (Pl. VIII).

JAPANESE MANAGEMENT OF BAMBOO GROVES.

One of the best posted bamboo growers in Japan informed the writer that twenty years ago he did not know that his groves, which were then in a neglected state, had any money value, but that to-day those parts of his farm on which the groves are situated are its most valuable portions. The attention which he bestows upon them now is very inexpensive, but almost as careful as that given to any other of his crops. The following forest methods are largely those which Mr. Tsuboi described as, from his experience, the best. These are applicable with slight variations to the three principal timber bamboos in Japan, and pertain in a general way to the culture of the ornamental species.

The land chosen for a bamboo grove should be dug over to a depth of 1½ feet the autumn previous to being planted, and, if a heavy soil, should have worked into it a good quantity of trash from the stable. The plants should be set out at an equal distance from each other at the rate of about 300 to an acre, or 12 feet apart each way. If the soil is a dry one, the ball of earth and roots should be planted below the surface of the soil, but if a wet one a mound should be made and the plants set in the upper portion of it. After planting it is important, as already remarked, that the soil between the plants should be given a heavy mulch of straw, under which is a layer of cow manure. This mulch should be maintained during the entire year. In the beginning the roots should be supplied with an abundance of water and in the autumn should be given plenty of rotted manure. If some of the plants die, they should be replaced by others so as to maintain as complete a stand as possible. It is essential as the new shoots spring up that the ground at their bases should be shaded by the foliage. The semiobscurity of a Japanese grove is not only its greatest charm, but one of the necessary factors of its growth. The sooner the ground can be shaded by the plants the better.

For the first three years at least all the shoots that appear should be allowed to mature, but after the grove is once well established only the largest shoots should be permitted to grow, the others being cut out as soon as they appear above the ground. This thinning process throws the strength of the plants into a comparatively few large culms, and gradually increases the height and strength of the forest.

In regions where the snows are so heavy that they break down the plants the practice of bringing the tops of several culms together and fastening them with rope is sometimes followed. The wigwam-like masses formed in this way are able to support without injury the weight of snow.

No culm should be cut for timber purposes until it is at least four years old, as before this time the wood is not mature. On the other

hand, if left standing too long the wood becomes too brittle and loses in value, and the forest besides is benefited by the cutting out of the four-year-old stems. The crop of new shoots is larger. This thinning-out process should be so done that as few gaps as possible are made in the forest and the semiobscurity below the mass of foliage is maintained.

The crop of new shoots varies in size every alternate year. A poor crop would mean 6 to 7 per cent of new shoots and a good crop 12 to 14 per cent. As there are commonly 10,000 culms in a hectare[a] (or 4,545 in an acre) of properly planted grove ten to fifteen years old, this would mean the production of 600 to 700 culms per hectare for a light crop and 1,200 to 1,400 for a heavy one. These figures were very kindly furnished the writer by Dr. T. Shiga, chief of the imperial forest management in Tokyo.

The experience of Mr. Tsuboi has been that some kinds of forest trees if standing in a grove prevent the growth of the bamboos near them. Oaks and chestnuts, he declares, are especially objectionable in this respect, while persimmons do not seem to affect in the least the production of new bamboo shoots. The effect of weeds in a forest is undesirable, and although comparatively few species are able to live in such a deep shade these should be dug out as from any cultivated field. Attention to these various details makes a great difference in the amount and quality of timber produced. A grove is not to be looked upon as merely a thicket and left to take care of itself, but as a plant culture which requires attention. Plates II and III show the effects of different methods of treating parts of the same grove.

One important element in the culture of this peculiar timber plant is the fact that a whole forest may bloom and die in a single season, and that it is not possible—as yet—to tell beforehand when this blooming will take place. The intervals between these periods are, however, so long that they are not taken into consideration by the Japanese farmer when he buys a bamboo grove. Little accurate information is obtainable regarding the length of life of the various Japanese species, but *Phyllostachys henonis* has the reputation in Japan of blooming oftener than either *P. quilioi*, *P. mitis*, or *P. nigra*, the other three important timber species. A small grove near Kawasaki which bloomed this season (1902) was reported by the owner to have once bloomed about sixty years before. As there always remain in the field a number of living rhizomes, after the death of the forest, these renew the latter in a few years, so that the actual loss to the owner does not include the cost of replanting. This is the case at least with the Japanese bamboos. As culms which have bloomed are poor in quality, the practice is followed of cutting them as soon as possible after they show signs of blooming.

[a] About 2½ acres.

In Japan, where bamboos and rice are often grown in adjoining plats of ground, some trouble is experienced from the underground stems spreading into the neighboring fields. To prevent this a ditch 2 feet wide and as many feet deep is dug about the grove and kept open by several rediggings during the year. This method is said to be a satisfactory one. It is a difficult matter, however, after a field has once been planted to bamboos, to clear it satisfactorily for other crops, for there is a mass of these tough rhizomes that are very difficult to dig out.

The harvesting of bamboo poles is not done before August, as culms cut earlier than this date are likely to be attacked by insects, not having had time to sufficiently harden. A Kyoto grower of black bamboos remarked that the Kobe exporters, by insisting on having their bamboos for export cut earlier than this date, had seriously injured the foreign demand, as the quality of the wood was much injured by this early harvest.

A saw is often used in cutting the shoots, by making cuts on opposite sides of it near the base. When cut, the poles are classified, tied into bundles, and stacked like hop or bean poles to dry. In the lumber yards of Japan these stacked poles of bamboo form a prominent feature.

PROFITS OF BAMBOO CULTURE IN JAPAN.

Dr. Shiga, chief of the bureau of forest management of Japan, when asked whether bamboo growing was profitable or not, said promptly that it was the best paying plant culture in the country, yielding a net return of 250 yen per hectare, which is the equivalent of about $50 gold per acre. The species referred to by Mr. Shiga in this case was the edible one. Twenty per cent of this amount represents the profits from the sale of edible shoots. Mr. Tsuboi's profits on his groves of *Phyllostachys quilioi*, a strictly timber species, averaged $20 an acre, while those of one of his friends near Kyoto were $40. The profits of a good grove of edible bamboo are evidently greater than those from one grown for timber only, and the author was informed by one of the best bamboo growers near Kyoto that his profits per acre were about $90 on land which, cleared of bamboo, would not bring more than $80, while good rice land sold for $200. A second grower of bamboos near Kyoto, who ships for the export trade from Kobe, informed the writer that the culture in his province of *Phyllostachys quilioi* yields a net income of about $40 per acre, while *P. henonis* brings in only about $30. Five years ago the black bamboo brought in a profit of $200 per acre, but now scarcely nets $50. Rice culture in this region, according to Mr. Tsuboi, barely pays more than for the cost of labor and manure, the former reckoned at 35 to 40 sen, or 17½ to 20 cents gold, a day. All of these figures, however,

have no practical bearing on the profits of bamboo growing in America, where a market for the culms can only be made after a constant reasonable supply has been assured.

The cost of the attention which is necessary in order to grow bamboos is so much less than that required for rice growing, suitable land is so much cheaper, and so much less risk is run from bad weather, that the statement that it is the best paying culture in Japan seems correct, and such inquiries tend to confirm it.

CULTURE OF THE EDIBLE BAMBOO.

Only one species of bamboo is commonly grown in Japan for food, and this is the largest one (*Phyllostachys mitis*), known as "Moso." It was introduced from China, where its value as a food plant has been known for centuries, and its common name indicates its origin.[a] One other sort, *P. aurea*, is also said to have edible shoots, but those of the remaining kinds are understood to be too bitter to be eaten.

The method of cultivating this species differs from that described for the timber sorts. The best soil is a more friable one, and if not naturally with a good admixture of sand it must be top dressed every year with 1 inch of light sandy loam and a mulching of straw or grass and weeds cut from the meadow. The young plants are set out more sparsely than if designed for timber, not more than 120 to the acre. Liquid manure is given freely to the newly set out plants, and as long as they are grown for their edible shoots large amounts of rich fertilizer containing much soluble nitrogen must be supplied them. In Japan the cost of the fertilizer is the principal expense of cultivation. In five years, if the transplanted mother plants are of good size, they should yield shoots large enough for sale, but ten years are required to bring the plantation into a profitable bearing condition. Weeding is done more carefully than in timber groves, though for the first five or six years all the shoots which come up are allowed to stand; but later, when the plantation is established, all small-sized ones are promptly removed as soon as they appear above ground. In order to obtain a supply of fresh culms a regular system in cutting out the old ones is followed. A definite number of selected stems, as soon as they are fully grown, are marked with the year of their production, and nine years later all of those bearing the same date are cut out. Each spring the same number (about 80 per acre) of new culms are spared from being dug out when small for market, and each autumn a similar

[a] Moso is the name of one of the twenty-four paragons of Chinese filial piety. The story is the case of a boy whose widowed mother fell ill and longed for broth made of young bamboo shoots. The shoots not being procurable in winter, his devotion was such that he went out in the snow to dig for them. The gods rewarded his devotion by causing the shoots to grow suddenly to an unheard-of size. Japanese artists are fond of illustrating their works of art with drawings of the boy Moso.

number of 9-year-old stems are cut and sold for timber. These are only a small proportion of the total number of bamboos on an acre, for this ranges from 640 to 680. If this system of thinning out is followed a plantation may be kept in bearing almost indefinitely. Near Kyoto the practice is followed of cutting off the top of every shoot left standing, before it is fully mature, to a height of from 12 to 14 feet. This prevents the wind from moving the culms too much and induces the formation of a bushy mass of luxuriant foliage and a great number of medium-sized shoots, which are more profitable than the few larger-sized ones that result if the mother plants are not topped.

The tenderest shoots and those which bring the highest prices are the ones dug up before their tips have pierced the surface of the soil. These bring, early in the season, as much as 1 yen per "kwan" (about 6 cents gold per pound), while the later product must sometimes be disposed of for a tenth of this price. The market season in Tokyo begins in December and closes in June. Although bamboo shoots are very nutritious, they are not easily digested, and many Americans do not like them for this reason. Old residents in Japan, however, often grow very fond of them and have adapted them to their Western menu.

Miss Fanny Eldredge, of Yokohama, has very kindly furnished the following recipes for cooking bamboo shoots:

1. *Bamboo sprouts with cream sauce.*—These sprouts are cut when about a foot above the ground, by digging down to the rhizomes which bear them. After being gathered, the outside sheaths are removed and the shoots are soaked for half an hour in cold water. They are then cut in thin slices, about 3 inches long by 1 inch square, and thrown into boiling water containing a small teaspoonful of salt, and are boiled from an hour to an hour and a half, or until tender. The pieces are then drained and a white sauce is poured over them, which is made in the following way: To a half pint of cream or milk add a teaspoonful of butter; season with salt and black pepper. Allow this to boil up and serve at once. If desired, this sauce may be thickened with flour.

2. *Bamboo shoots in butter.*—Slice and cook as in the previous recipe, until tender. Into a saucepan put three tablespoonfuls of butter, seasoned with pepper, salt, and a little chopped parsley. When heated, put in the bamboo. Shake and turn until the mixture boils; then lay the bamboo on a hot platter, pour the butter over it, and serve at once.

3. *Bamboo shoots, Japanese style.*—Slice and cook the bamboo until tender, as in recipe No. 1; then put into a sauce made as follows: Take one coffee cup full of soy sauce (this is the basis of Worcestershire sauce and obtained only at Chinese or Japanese grocers or at some of the largest groceries in our large cities), one-fourth cupful of water, one heaping teaspoonful of sugar; let boil for half an hour in this sauce, and serve.

DIFFERENT SPECIES OF BAMBOOS.

The bamboo family is a large one and scattered over a great portion of the warmer and mountain regions of the globe, and, owing to the fact that the plants so infrequently bloom and that their classification

depends upon the characters of the flower, it is not a very well-known group of plants. The monograph by Munro[a] is one of the most comprehensive attempts to give in one book descriptions of all of the known species. Of the hundreds of described forms only a small proportion are of much economic importance, and of these only a few are hardy. When the interior of China, the slopes of the Himalayas and Andes, and the mountains of the Malay Archipelago have been searched over for valuable hardy forms, the comparatively short list of species suitable for introduction will doubtless be largely increased. Anyone wishing to know what a large territory there is to search over for hardy bamboos and how many remain to be introduced and tested, will find these subjects discussed in a very interesting chapter called, "Future possibilities," in Mr. Mitford's book, "The Bamboo Garden." Nor should attention be confined to the hardy forms, when the tropical species are so many and various and have been so little studied from an economic standpoint. There are forms in Burma which could doubtless be introduced with great advantage into the Philippines, and species from the semi-tropical regions of China which are worthy of establishing in Hawaii. In fact, the more familiar one becomes with the bamboo question the truer does Mr. Mitford's statement, from the aesthetic standpoint, appear, that "we have only touched the fringe of what we may hope to achieve in the decoration of our wilderness gardens with the grace of these royal grasses."

At present, only a limited number of forms are eligible for introduction into the United States, and the majority of these are found in Japan.

The following popular descriptions of the more important economic sorts are given to assist in determining those common species which may be introduced in the near future, or which are already growing in America. The nomenclature followed is that given by Mr. Mitford in his "Bamboo Garden," except in such species as are not included by him, when Sir Ernest Satow's work, "The Cultivation of Bamboos in Japan," is followed. This is not an attempt to clear up the nomenclature of these badly mixed species.

The different common species of Japanese bamboos which resemble each other have been so often taken for one another that a convenient method of telling them apart is a very desirable thing. Such a method Sir Ernest Satow has drawn attention to in his book. It consists in comparing the forms and markings of the sheaths that surround the young shoots and in the leaf-like appendages or pseudophylls which are borne at their tips. He has published colored plates to illustrate

[a] Monograph of the Bambusaceæ, including descriptions of all the species. London, 1870, 157 pp.

these characters. The difficulty in using them, however, is that the sheaths are only obtainable in the season when there are young shoots. Mr. Mitford points out that the form and coloration of the winter buds in the axils of the branches, from which new branches develop, are important means of distinguishing the species. The characters which determine whether a bamboo belongs to the *Bambusa*, *Phyllostachys*, or *Arundinaria* genera, which are all it is necessary to consider here, are unfortunately largely floral ones and for practical purposes nearly useless. The genus *Bambusa* belongs to a section (*Bambusæ veræ*) in which the flowers have six stamens, while *Phyllostachys* and *Arundinaria* both belong to the *Triglossæ* section, where the flowers have three stamens. *Arundinaria* is distinguished from *Phyllostachys* by having round stems, while those of the latter are grooved or slightly flattened on one side. The sheaths in *Arundinaria* remain attached much longer than in *Phyllostachys*, as a rule those of the latter genus dropping off as soon as the culms are mature.

Phyllostachys Mitis, A. & C. Rivière.

(Japanese name: "*Moso-chiku*" or "*Mouso-chiku.*")

The largest hardy species in Japan, growing to a height of over 50 feet and producing, not uncommonly, culms over 6 inches in diameter. In England specimens have been grown to a height of 19 feet and a diameter of 1½ inches. *The culms are gently curved shortly after leaving the ground*, while those of other sorts with which it might be confused rise straight from the base. (Compare figs. 1 and 3, Pl. IV.) Its sheaths are of a light-brown color, *marked with dark umber-brown blotches and round dots* and covered with bristles. The pseudophyll is broad at the base, tapers to a point, *but is not wavy in outline*. The sheath spreads right and left from the base of the pseudophyll and is fringed throughout with hairs, which are straight when they lie between the pseudophyll and the stem, but curled on the right and left sides where they are free to develop. The internodes are generally shorter than those of the other large species and *the leaf sheaths are fringed at the insertion of the leaf with a number of rather coarse hairs*. The branch buds are purplish brown and strongly marked. The leaves vary from 1 to 6 inches in length and are too variable to be convenient characters for quick determination. This is the great edible bamboo of Japan and China, the method of cultivation of which has been described. It is not as hardy in England as *Phyllostachys quilioi* and *P. henonis*.

Phyllostachys Quilioi, A. & C. Rivière.

(Japanese name: "*Madake.*")

The second largest hardy species, growing to a height of 30 to 40 feet in Japan and 18 feet in England, with a diameter of 4 inches and 1¼ inches, respectively. The great timber bamboo of the Japanese.

The culms rise straight from the rhizome, and the branches are proportionately long, compared with the height of the stem.

Its sheaths are marked with *purple or reddish blotches, which are much more pronounced in character than those of the preceding species, and the pseudophyll has a wavy outline.* The branch buds have green bases, and only the tips are brown. The new shoots appear above ground in Japan a month later than those of the following species (*P. henonis*), that is, in June. The internodes are proportionately longer than those of *P. mitis*, but the leaf sheaths are fringed with long hairs, as they are in that species. The leaves vary in length from 2 to 8 inches, but are proportionately broader, according to Mitford. This species is hardy in England and has a more vigorously spreading rhizome than that of *P. mitis* or *P. aurea*.

Phyllostachys Henonis, Mitford.

(Japanese name: "*Hachiku.*")

A somewhat smaller kind of bamboo than the preceding two species. Considered by Mitford the prettiest one cultivated in England. Height in Japan from 20 to 30 feet, with a maximum diameter of a trifle over 3 inches. In England specimens 14 feet high and one-half inch in diameter occur. After *P. mitis* and *P. quilioi* the commonest timber form in Japan. Culms rise straight from the base. *Sheaths are a straw color, with few or no spots of any kind and with a distinctly wavy pseudophyll* like the blade of a Malay *kris*. New shoots appear before those of *P. quilioi* that is, in April and May. The leaf sheaths are fringed (at least on young plants) with delicate hairs, which are *neither so long nor bristlelike as those in P. mitis and P. quilioi.* Branch buds are a pale yellowish-green. The pipe is thinner walled than that of *P. quilioi*, and its use in the arts is restricted because of the inferior quality of the wood. The rootstock is said to run freely in England, where it has proved hardy.

"Madaradake" or "Ummon-chiku."

A form closely related to *P. henonis*, which is distinguished by having dark blotches on its culms that are presumably caused by some as yet undetermined species of fungus. These spots are regularly present on almost all internodes and give to the stems a very decorative appearance, making them much sought after for fancy furniture. The extent and beauty of these blotches vary with the amount of shade which the plants are given and the kind of soil upon which they are grown. The best location is said to be a moist river bottom, and the less direct sunlight that is permitted to strike the young shoots when in growth the better. A rare sort, except in certain localities in Japan. Some of the best groves the writer has seen are in Hikone, in the province of Mino, on Lake Biwa.

PHYLLOSTACHYS NIGRA, MUNRO.

(JAPANESE NAMES: "*Goñadaké*," "*Kuro-chiku*," or "*Kurodaké*.")

The black bamboo is not as generally grown in Japan as the three species just mentioned, but it is nevertheless an important culture. Formerly more money was made out of it than has been the case in recent years, because the foreign demand, it is said, has fallen off.

It is a smaller species than the other timber sorts, seldom growing over 20 feet high and 1½ inches in diameter.

The culms when young are covered with dark-brown to purple spots, which spread as it grows older until the whole culm becomes dark-brown, almost black, except just below the nodes, where there is an ash-gray line. This dark color at once distinguishes the species from all other Japanese sorts. Branch buds are brown, mottled with black. There is a great variation in the intensity of this dark color of the culms, and this is said to vary with the kind of soil upon which the plants are grown and the amount of sunlight to which they are exposed. There are, however, at least two varieties of this species, one with much more intensely brown culms than the other. Mr. Mitford calls the lighter sort *P. nigro-punctata*, and remarks that it is hardier than *P. nigra*, but not so pretty. Light, hillside soil is claimed as better adapted to the production of intense color than rich alluvium, and it is found necessary to renew old plantations, in order to prevent the color from fading out.

This is one of the hardiest forms grown in England, attaining in exceptional cases 20 feet in height, and it is certainly one of the most decorative kinds. Nothing could exceed the delicate beauty of the groves of this species which are to be seen near Kyoto. Their dark stems, ash-gray nodes, and light-green foliage make them unique among decorative plants. (See Pl. I.)

The uses of this species are limited to the manufacture of furniture, numerous household articles, and fancy fishing poles, for all of which these black bamboos are peculiarly suited.

PHYLLOSTACHYS CASTILLONIS.[a]

(JAPANESE NAME: "*Kimmei-chiku*.")

The golden-striped bamboo is one of the most decorative forms of the group. It is not easily confused with other Japanese sorts when its characters are fully developed, for each culm is of a beautiful golden-yellow color, striped with brilliant green. The leaves also are variegated with stripes of green and white. The contrast between the golden yellow of the stems and the green stripes on the young

[a] No authority is given by Mitford for this name, and the author has been unable as yet to work out its correct name. The nomenclature of the bamboos needs working over.

shoots is one of the prettiest effects imaginable. The species grows occasionally over 30 feet high in Japan and specimens 5 to 6 feet high are already found in England, where the species has withstood a temperature of 24 degrees of frost or 8° F. It is not a common species even in the gardens of Japan, and Mr. Mitford says it is uncommon in England. Very young plants sometimes show only slight traces of the variegation on the stems, but develop this character later.

Mr. Tsuboi, who has the most exceptional taste in bamboos, and in the dwarfing of which he is an acknowledged connoisseur (see Pl. VII, fig. 1), suggested planting a mixture of this golden bamboo with the black species, *P. nigra*. As a rule, mixtures of bamboos are said to be objectionable, but such a mingling of golden and black stems is worthy of an experiment.

Phyllostachys Aurea, A. & C. Rivière.

(Japanese names: "*Hotei-chiku,*" "*Hôrai-Chiku,*" or "*Taibo-Chiku.*")

A smaller species than *P. mitis* or *P. quilioi*, but attaining in England a height of 14 feet and a diameter of culm of over three-fourths of an inch. In Japan, culms have been observed over 1½ inches in diameter. It is not a golden bamboo, as its name implies, its stems being about the color of *P. mitis*. The distinguishing characteristic is that the first 5 or 6 internodes near the ground are very short, bringing the internodes, or joints, close together, often only a few inches apart. These joints are not, as in *P. heterocycla*, set at an angle to the direction of the stem, but are generally parallel to each other and quite horizontal. Branch buds are variable in color, but pale. Mr. Mitford remarks that this species should be planted in large, bold masses for good landscape effect, for if single plants are set out they send up shoots only near the mother culm and produce a switch-like effect. The shoots of this species are edible, according to the Japanese books, and are of even better flavor than those of *P. mitis;* but this variety does not appear to be grown for food.

Phyllostachys Bambusoides, Sieb. & Zucc.

(Japanese name: "*Yadake.*")

The arrow bamboo is that of which the stems are still employed in the manufacture of the fine Japanese arrows used generally for archery purposes. The plant is still a rare one in England, and Mitford says that other sorts are sometimes sold by Japanese nurserymen under its name. It is not very commonly seen in gardens, so far as observed, even in Japan, and the arrow makers, it is said, get their main supply of stems from wild plants. There are some of these manufacturers in the town of Shizuoka, but the demand for arrows is so small that they are doing a poor business. This species is distinguished from others

by the fact that it does not have an actively creeping rootstock. Each plant forms a separate small clump by itself. The branches are shorter than the internodes and the middle branch of the three is longest, whereas in other bamboos the middle branch is the shortest—sometimes wanting. Clumps of this form grow to 10 or 12 feet in height in Japan, with a diameter of little over three-fourths of an inch. The internodes are long, and the sheaths, although withering the first year, do not fall off until the following year. They are bright green in color, with a purple edging. The leaves are large, sometimes over 12 inches long by 1¼ inches broad, and are borne in fours, fives, sevens, or eights. The hardness of the culms, their small cavity, and the smoothness of the nodes, as well as their small size, are characteristics that well adapt them for arrow making. This is believed to be a hardy species, and it is quite unlike the ordinary bamboos in appearance.

Phyllostachys Marliacea, Mitford.

(Japanese names: "*Shibo-chiku*" or "*Shiwa-chiku.*")

The "wrinkled bamboo" is easily distinguished from all other kinds by the fact that its culms are longitudinally channeled with shallow grooves. It is a low-growing species compared with *P. quilioi*, which it otherwise resembles, not being commonly over 12 to 14 feet high, even in Japan. It is a rare kind, and its culms are used occasionally, it is said, for decorative woodwork in the special rooms which in many Japanese houses are kept sacred for the tea-drinking ceremony. A beautiful and hardy form.

Arundinaria Japonica, Sieb. & Zucc.

(Japanese name: "*Métaké*" or *Médaké;*" not "*Makade.*")

A well-known bamboo in Europe, where it is not very highly thought of by some, but is praised as a valuable decorative plant by others. A form distinguishable by its persistent sheaths which, instead of falling off, like those of the genus *Phyllostachys*, remain attached until they become frayed out and split to pieces. These ragged sheaths give to clumps of the plant an untidy appearance. The culms are round and without any groove or flattening on one side, as is the case with the Phyllostachides. The pseudophylls of the ordinary sheaths are very narrow, sometimes not over an eighth of an inch wide, and from 1 to 2 inches long; but those of the topmost sheaths develop into true leaves. The leaves themselves are large, 8 to 12 inches by 1½ to 2 inches. This is said to be the hardiest species in Japan, growing as far north as the island of Hokkaido, where the temperature falls below zero Fahrenheit. Its culms are extensively used for fan making, and millions of cheap paper-colored fans are made every year from the

stems of this species. River banks and the margins of ponds and canals are eminently suited to its growth, and the overflowed lands of the Colorado River in Arizona might be planted to advantage with this species. This bamboo is one of the few that has flowered and fruited in Europe. According to Mr. Mitford, specimens in the Bois de Bologne in Paris, and simultaneously all over France and in Algiers, bloomed and produced fruit in 1867 or 1868.

Arundinaria Simoni, A. & C. Rivière.

(Japanese name: "*Narihiradake.*")

This species is easily distinguished by its broad, persistent sheaths of a plain straw color that fall off only after the culms have attained maturity. (Pl. V, fig. 1.) It is the tallest of the hardy arundinarias which are grown in England, the culms attaining a height of 18 feet and a diameter of an inch. The shoots appear from midsummer until late in the autumn, and Mr. Mitford remarks that many do not mature sufficiently to stand the English winters. The sheaths nearest the ground are short, though long enough to overlap the internodes, but those of the upper joints, although 8 to 10 inches long, do not exceed the internodes in length. They are at first of a fine green color, shading into purple, which soon fades, however, to a dull yellow. These prominent sheaths, which are thick, stiff, and beautifully glazed on the side next the culm, will easily distinguish this arundinaria from any other common Japanese form. The species has flowered and fruited in England, and it is quite universally grown in English gardens. A long description of it is given by Mr. Mitford in "The Bamboo Garden."

Arundinaria Hindsii, Munro.

(Japanese name: "*Kanzan-chiku.*")

The Kanzan-chiku is a very common garden plant about Tokyo, and clumps of it are to be found in many of the farmyards in central Japan, where the culms grow to a height of 18 feet and attain a diameter of over $1\frac{1}{3}$ inches. This species forms pretty clumps, with a fine grass-like foliage, and although little farm use is made of it, it is worthy of trial as an ornamental. Its hardiness has not been demonstrated in England, but it seems likely to prove as hardy as forms like *P. mitis*. It is distinguished from the preceding arundinarias by its long, narrow leaves, sometimes 9 inches by five-eighths of an inch, according to Mr. Mitford. The sheath is provided with a reddish margin toward the tip.

Arundinaria Hindsii, var. Graminea.

(Japanese name: "*Taimin-chiku.*")

A sort similar to the foregoing, but with considerably narrower leaves and a longer, narrower sheath, with no evidences of a brown margin.

Bambusa Veitchii, Carr.

(Synonym: *Arundinaria veitchii.* Japanese name: "*Kokumazasa;*" sometimes only "*Kumazasa.*")

The Kumazasa, by which is generally meant *Bambusa palmata*, and this *B. veitchii* are sometimes confused. The latter may be distinguished by the fact that its leaf margins wither in late autumn and make the plant look as if it were variegated. *B. veitchii* is furthermore, as a rule, only about 2 feet high, whereas *B. palmata* grows to 5 feet in height. The sheath of *B. veitchii* is said by Sir Ernest Satow to be longer and more persistent than that of *B. palmata.* The leaves of *B. veitchii* are much smaller than those of its taller relative and warrant the name of "Kokumazasa," or lesser bamboo. This species is suitable for lawn planting and is used by the Japanese to plant under their pine trees and to cover with a thick mat of green foliage a sloping hillside or embankment, for both of which purposes it is admirably adapted (Pl. V). It must be kept from spreading into cultivated ground by means of a broad ditch, 2 feet deep and 1½ feet wide. The variegated effect produced by the dead margins of the leaves after being touched by frost is striking, though not very attractive.

Bambusa Palmata, Hort. Ex. Kew Bull.

(Japanese name: "*Kumazasa.*")

A much larger species than the preceding and with leaves 12 to 13 inches long instead of 5 to 6 inches. Altogether one of the most effective plants for embankments, as it covers them with a mass of broad leaf surface which is very attractive. Its rhizomes are said to be good sand-binders. Large patches of this plant on a lawn or hillside are striking objects of interest. Caution must be exercised to prevent the rhizomes from invading cultivated fields. This can be done by ditching, as has been described for *B. veitchii.*

Bambusa Quadrangularis, Fenzi.

(Japanese names: "*Shiho-chiku*" or "*Shikaku-daké.*")

The square bamboo is unlike any other Japanese species in the possession, when fully grown, of square culms. These square stems are often not apparent on young small shoots, but the older ones are sure

to show this character. The squareness of these culms is aptly compared by Mr. Mitford to the square stems of the Labiates. Small groves of this bamboo are to be seen not far from Yokohama, and the writer has seen stems among one of these groves that were about 20 feet high, while Mr. Mitford says the plant grows to 30 feet near Osaka. The sheath is very thin and delicate and more open than in most bamboos, gaping from the base and leaving the greater part of the internode uncovered. The wood of this species is too weak to make it of any great value, and its sensitiveness to frost is too great to enable one to class it among the hardy sorts. It is, however, a decorative plant and worthy of repeated trials in the frostless regions of America. It is said that roots will form easily from the lower nodes of the square bamboo if the portion bearing these nodes is buried in the soil. This would facilitate propagation if the statement proves correct.

Bambusa Vulgaris, Schrad.

(Japanese name: "*Taisau-chiku.*")

A species growing in Satsuma, the southern province of Japan, but which is not hardy at Yokohama. It is propagated differently from the hardy sorts, as new shoots are borne from the base of the culm as well as from the rhizome. Short culm bases, without rhizomes, are potted and easily transported from Satsuma to Yokohama, where new branches appear from the nodes. This species is said to be easy to propagate because of this character, but it will probably have a chance to succeed in the United States only in subtropical Florida and Texas, where it will require a good soil, rich in humus.

"Shakutan."

"Shakutan" is the name of a very pretty species which is reported to grow in the northern island of Japan and to be perfectly hardy. The writer saw plants under this name in the Yokohama Nursery Company's grounds. They were very distinct from *B. palmata*, and dried specimens were sent to Mr. Makino in Tokyo for determination. The species is probably related to *B. palmata*, but the broad, large leaves are mostly situated near the tip of the slender sheath-covered stem, which rises from the ground with a characteristic curve, and is bare of leaves for several feet from the ground.

Plate V, fig. 3, shows a clump of what appears to be the same species, from Tosa, one of the southern islands of Japan, which was growing in Mr. Tsuboi's garden under the name "Hanchiku." The culms are almost covered with the light-colored persistent sheaths from the ground to the leaves. The stems are not over one-fourth to three-eighths of an inch in diameter, and are about 5 feet high.

PLATES.

DESCRIPTION OF PLATES.

PLATE I. A commercial grove of the black bamboo (*Phyllostachys nigra*) growing at Kaiden, Shinkotari, near Kyoto, the property of Mr. Denkichi Fujibayashi. Age unknown, but probably more than 30 years old. Photographed by Yendo.

PLATE II. A well-kept forest of *Phyllostachys quilioi* growing on good soil, showing an open drainage ditch in foreground and the thick mulch of leaves and straw which cover the ground. Age probably over 50 years. Photographed by Yendo.

PLATE III. Bamboo forests. *Fig. 1.*—A well-kept forest of *Phyllostachys quilioi* growing on poor soil filled with gravel Weeding has not been as recently done as in that part of the forest shown in Pl. II. The two photographs from which these plates were prepared were taken from points not 20 yards apart in the forest of Mr. Isuke Tsuboi, of Kusafuka. Photographed by Yendo. *Fig. 2.*—A badly kept forest of timber bamboo (*Phyllostachys quilioi*) growing on good soil adjacent to the well-kept forest shown in Pl. II. This shows the effect of not weeding, thinning out, or fertilizing. Photographed by Yendo.

PLATE IV. Bamboo groves in Japan. *Fig. 1.*—A hillside grove or forest of the edible species (*Phyllostachys mitis*) 20 years old, showing large size of the culms. *Fig. 2.*—A grove of the same species over 100 years old near Tokyo. The bundle of barley straw shown on the right will be used for mulching purposes. *Fig. 3.*—A 12-day-old shoot of *Phyllostachys quilioi* in a forest of the same species on Mr. Tsuboi's place at Kusafuka.

PLATE V. Bamboo groves in Japan. *Fig. 1.*—Clump of *Arundinaria simoni*, showing the persistent characteristic sheaths. *Fig. 2.*—Grove of *Phyllostachys quilioi* on Mr. Tsuboi's place at Kusafuka. Age unknown, but probably more than 50 years old. *Fig. 3.*—Plat of a species of bamboo called by Mr. Tsuboi "Hanchiku," from Tosa Island, which has not been determined botanically so far as known. An exceedingly pretty, decorative form, somewhat like *Phyllostachys palmata*.

PLATE VI. Bamboo plants. *Fig. 1.*—A young black bamboo plant of which the rhizome, to be seen on the left, has died. The rosette of leaves still remains alive, but no young shoots are formed. This specimen was dug in Mr. Tsuboi's garden at Kusafuka. Photographed by Yendo. *Fig. 2.*—Properly dug young plant of black bamboo ready to transplant, showing several inches of rhizome on both sides of the base of the stem, which is necessary for the production of new shoots. This specimen was dug under Mr. Tsuboi's direction and represents his idea of how a plant should be prepared for transplanting if dug late in the season. Photographed by Yendo. *Fig. 3.*—Rhizome or underground stem of bamboo (*Phyllostachys quilioi*), showing young shoots and roots springing from the nodes. Dug in June. If dug in winter, the buds would all be in a dormant condition. Photographed by Yendo.

PLATE VII. Bamboo scenes. *Fig. 1.*—Dwarf bamboos at Kusafuka. *Fig. 2.*—Embankment on top of a wall in a city street in Tokyo planted with *Bambusa veitchii*. *Fig. 3.*—Young shoot showing effects of the bamboo culm-boring larva. Sawdust on outside of shoot affords evidence of presence of larva within. *Fig. 4.*—Longitudinal section of young shoot showing the culm-boring larva inside one of the segments. Photographed by Yendo.

PLATE VIII. Bamboos in California. *Figs. 1 and 3.*—Rows of *Phyllostachys quilioi* (?) growing 25 feet tall in the grounds of a nursery company at Niles. Watered twice a year with 2 inches of water each time. This species is called *Bambusa striata* by Mr. Rock. *Fig. 2.*—Plant of *Phyllostachys quilioi* (?) which was set out two years ago in the grounds of a nursery company at Niles.

A WELL-KEPT FOREST OF TIMBER BAMBOO (PHYLLOSTACHYS QUILIOI) ON GOOD SOIL.

FIG. 1.—A WELL-KEPT FOREST OF TIMBER BAMBOO (PHYLLOSTACHYS QUILIOI) ON POOR SOIL.

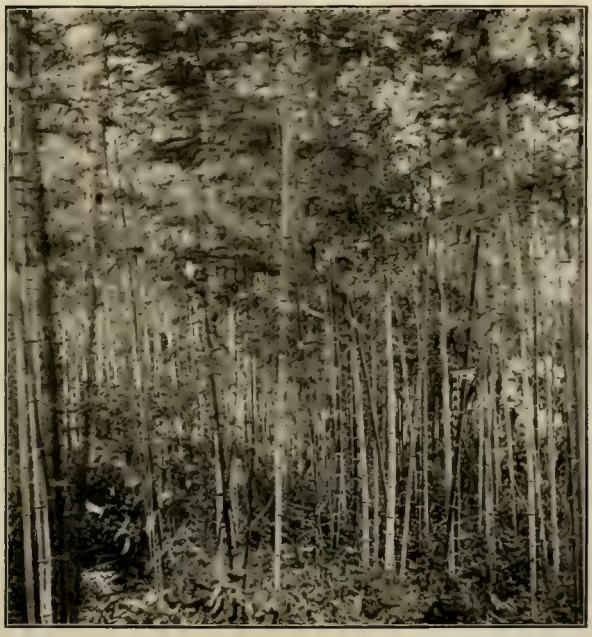

FIG. 2.—A BADLY KEPT FOREST OF TIMBER BAMBOO (PHYLLOSTACHYS QUILIOI) ON GOOD SOIL.

PLATE IV.

FIG. 1.—A HILLSIDE FOREST OF EDIBLE BAMBOO, 20 YEARS OLD.

FIG. 2.—A GROVE OF EDIBLE BAMBOO, MORE THAN 100 YEARS OLD.

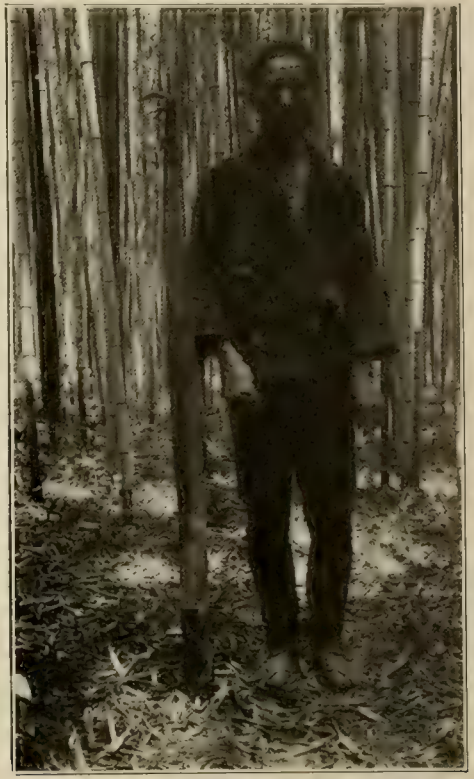

FIG. 3.—TWELVE-DAY-OLD SHOOT OF PHYLLOSTACHYS QUILIOI IN FOREST.

BAMBOO GROVES IN JAPAN.

B. P. I., Bureau of Plant Industry, U. S. Dept. of Agriculture.

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FIG. 1.—CLUMP OF ARUNDINARIA SIMONI, SHOWING PERSISTENT LEAF SHEATHS.

FIG. 2.—GROVE OF PHYLLOSTACHYS QUILIOI, AGE UNKNOWN.

FIG. 3.—PLOT OF SPECIES OF BAMBOO CALLED HANCHIKU.

BAMBOO GROVES IN JAPAN.

FIG. 1.—BLACK BAMBOO PLANT, SHOWING THE EFFECT OF THE DEATH OF THE RHIZOME.

FIG. 2.—PROPERLY DUG YOUNG PLANT OF BLACK BAMBOO.

FIG. 3.—RHIZOME OF BAMBOO WITH YOUNG SHOOTS AND ROOTS SPRINGING FROM NODES.

FIG. 1.—A FEW DWARF BAMBOOS.

FIG. 2.—EMBANKMENT OF BAMBUSA VEITCHII IN TOKYO.

FIG 3.—SAWDUST ON SHOOT, INDICATING PRESENCE OF CULM-BORING LARVA.

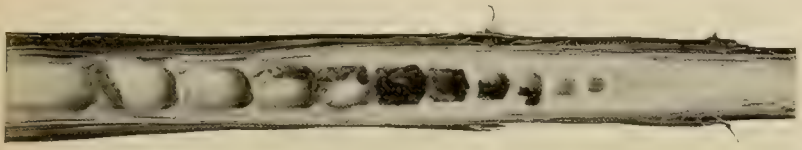

FIG. 4.—LONGITUDINAL SECTION OF SHOOT, SHOWING CULM-BORING LARVA.

PLATE VIII.

FIG. 1.—PHYLLOSTACHYS QUILIOI (?) AT NILES, CAL.

FIG. 2.—CLUMP OF PHYLLOSTACHYS QUILIOI THE SECOND YEAR AFTER TRANSPLANTING.

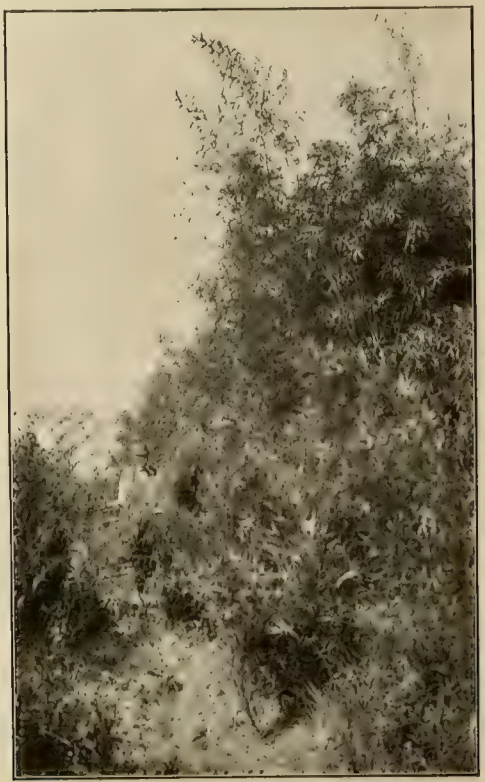

FIG. 3.—PHYLLOSTACHYS QUILIOI (?) AT NILES, CAL.

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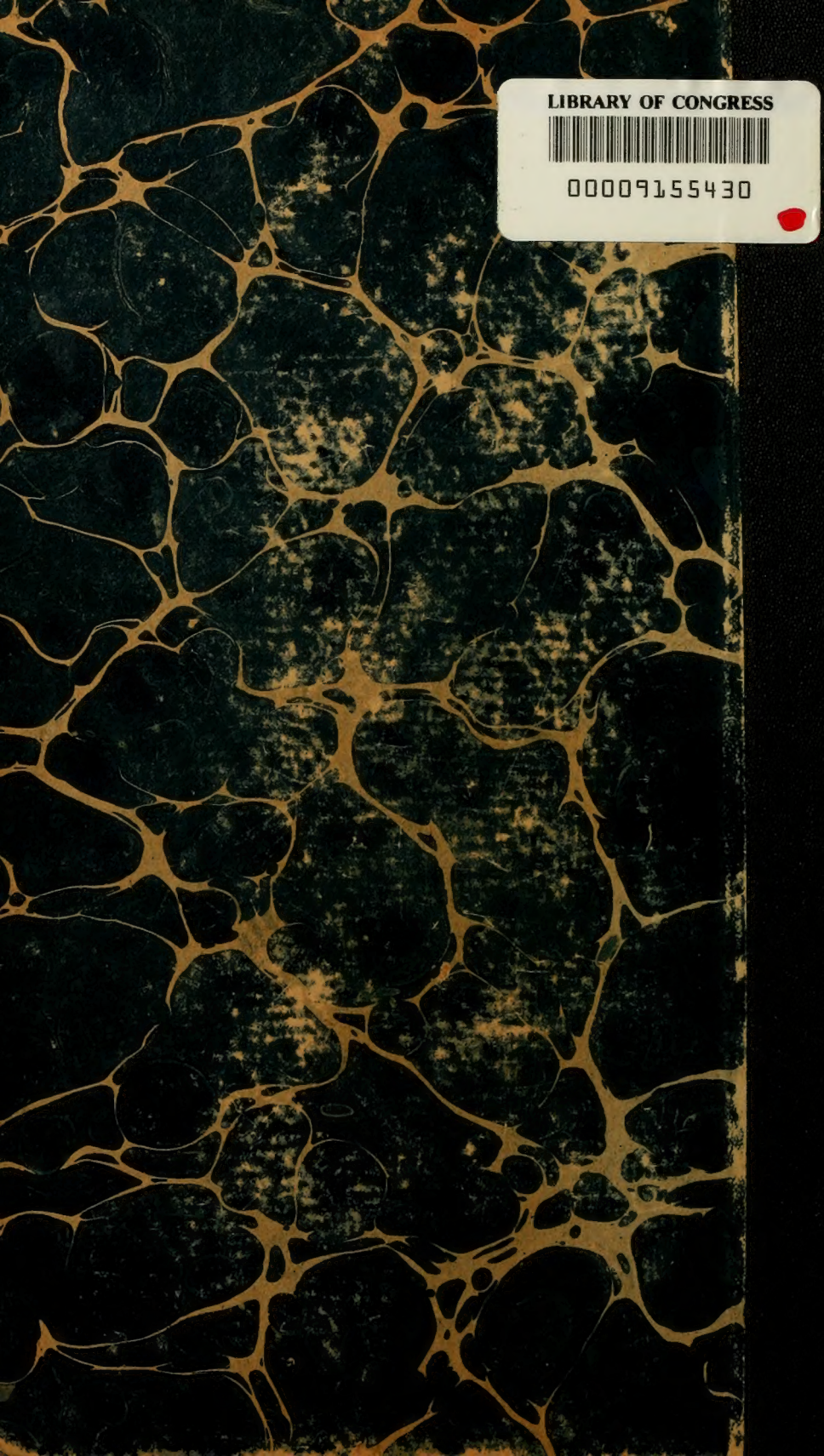
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